

for the presence of a wolf's tooth beneath an opossum's tooth in the same jaw. The creative energy in this case is neither governed by memory, nor by present necessity; but is intelligently prophetic of future emergencies. And that is precisely our simplest definition of *divine providence*. But it is also our simplest definition of *practical invention*. Combining the two, we get the view taken by Mr. Agassiz, instead of the view taken by Mr. Darwin.

Professor Cope exhibited also a very interesting tooth, which he named *Ptilodus mediævus*, from the Lower Eocene of New Mexico.

The importance of this discovery lies in the fact that it furnishes an intermediate link between the *Plagiaulax* of the Jura and the recent Australian *Hypsiptymnus*; which two instances of the general type have hitherto remained separated from each other by the whole Cretaceous and Tertiary interval.

Pending nominations, Nos. 934 to 945 were read.

The expediency of printing certain communications was referred for consideration to the Finance Committee.

On motion of Mr. Fraley, it was

Resolved, That the Society most earnestly recommends the appointment of Mr. J. E. Hilgard, as Superintendent of the Coast and Geodetic Surveys of the United States, believing him to be most eminently fitted for the discharge of the duties of the office, by his long and faithful services in conducting said surveys, and by his skill, ability, and full knowledge of all that is required to make said surveys honorable to the Government and useful to the people.

And the meeting was adjourned.

Notes on the Quinnimont Coal Group in Mercer Co. of West Virginia and Tazewell Co. of Virginia. By John J. Stevenson, Professor of Geology in the University of the City of New York.

(Read before the American Philosophical Society, Oct. 7, 1881.)

Bluestone creek, formed at the easterly edge of Tazewell county, Virginia, by the union of Laurel and Mud forks, flows across Mercer and Summers counties of West Virginia to the New river, which it reaches at about four miles south from Hinton, a station on the Chesapeake and Ohio railroad. It receives tributaries from the north, known as Little Bluestone, Mountain, Camp, Wolf, Wide Mouth, Flippon and Simmons creeks. The first four of these rise in an elevated ridge, known as Flat Top, which

separates the waters of Bluestone from those of the Guyandot. But beyond the head of Wolf creek, the streams rise in a narrow ridge, from whose opposite side flow those streams which form the Tug fork of Sandy river. This is a mere knife-edge, so narrow at times as barely to afford room for the country road, which follows its crest.

The surface features of the region on both sides of Bluestone and beyond the divide westward are due wholly to erosion. The carving is stupendous. Standing on any of the high points of Flat Top mountain and looking into Mercer county on the one side or into McDowell and Wyoming on the other, one can compare the surface only to that of an ocean petrified at the height of a terrible storm. But this comparison fails. Narrow ridges, rising to a height of 900 to 1400 feet, separate equally narrow valleys, in which flow rapid streams, carrying much water during a great part of the year. The slopes of these ridges are abrupt, sometimes reaching 35°, and are covered by a dense forest of white oak and poplar (tulip-tree).

The whole region is known as "Flat Top." All the summits between Flat Top mountain and Peters mountain have been planed off to a rudely level surface, a condition wholly independent of the dip, which north from Bluestone varies from 7° to a mere fraction of a degree. Beautifully perfect benches were seen at from 400 to 900 feet above Bluestone creek, in the ridges separating tributaries to that stream, while still higher benches were observed on Flat Top mountain. But as no spirit-level determinations were at hand along Bluestone, no notes were taken respecting the relations of these benches.

The influence of the Abb's Valley fault* is shown along the line of Bluestone, for there the dips are well marked, whereas as one goes northward from that stream, they become insignificant.

Along the New river at Hinton, a fine-grained, grit-like sandstone occurs, which belongs to the Mountain Limestone division of the Lower Carboniferous. It forms a cliff at numerous localities on the Chesapeake and Ohio railroad, both above and below Hinton, and can be traced along New river to the mouth of Bluestone, as well as up that stream to the mouth of Little Bluestone. Higher members of the group appear as one ascends the stream, and the Quinnimont coal group is reached before one comes to the junction of Laurel and Mud creeks, in Tazewell county of Virginia. The top of this group is not caught within the region visited, which extends only to four miles above the mouth of Laurel creek.

A section was obtained on Laurel creek, which does not reach the bottom of the Quinnimont group, but it embraces all of the important beds of the series. It is as follows :

1. Concealed.....	70'
2. Sandstone.....	10'
3. Drab Shale.....	20'
4. <i>Purdue Coal bed</i>	2'
5. Sandstone.....	20'

* Described by Prof. J. P. Lesley, Proc. Amer. Phil. Soc., 1872.

6. Concealed.....	45'
7. Sandstone.....	10'
8. Shale.....	0' 6''
9. <i>St. Clair Coal bed</i>	2'
10. Sandstone.....	55'
11. <i>Reed Coal bed</i>	3'
12. Sandstone.....	45'
13. <i>Tabor Coal bed</i>	3'
14. Sandstone.....	30'
15. <i>Coal Branch Coal bed</i>	9'
16. Sandstone.....	70'
17. <i>Nelson Coal bed</i>	11'
18. Sandstone and Shale.....	36'
19. <i>Coal bed</i>	1' 6''
20. Shale and Sandstone.....	34'
21. <i>Coal bed</i>	1'
22. Sandstone.....	23'
23. <i>Coal bed</i>	Blossom.

The section begins in McDowell county of West Virginia, on the divide separating Bluestone from Tug fork of Sandy river. It was obtained by examinations along Coal branch, Sluss' branch and Haines' Cabin branch, all entering Laurel creek, as well as upon the Tazewell and McDowell road and along Laurel creek itself. Laurel creek flows almost eastward and the head of Haines' Cabin branch is at 7 miles from the mouth of the creek. The top of the section was reached at the head of Haines' Cabin branch and of one fork of Coal branch. The highest beds are not shown, no coal blossom appears in the ploughed fields and only fragments of shale and sandstone are found in the débris covering them.

The blossom of the *Purdue coal bed* was seen on the Tazewell and McDowell road, very near the line between these counties. It was fully exposed near the same road in making an excavation for a spring-house on the Purdue property, where it is said to be 4 feet thick, but the exposure is insignificant now. A very good exposure was found near the head of one fork of Coal branch, at a watering trough on W. L. Reed's land, where very nearly 2 feet of coal are shown. The bed is said to be 4 feet thick in an adjacent hollow, but an exposure near Mr. Reed's house indicates a thickness of not more than 15 inches. The same bed was seen near the Reed school-house on another fork of Coal branch, and at Mr. J. Bailey's house at the head of Haines' cabin branch. It is unimportant at all the exposures observed. The rocks overlying it are shown only on W. L. Reed's property. The massive sandstone, No. 5, is persistent and everywhere marks the place of the *Purdue coal bed*. It is well shown at many places on both sides of the divide.

The interval between the *Purdue* and *St. Clair coal beds* varies from 73 to 80 feet, the former having been found on Haines' Cabin branch, and the latter on Coal branch. The exposure is not complete at any locality visited,

and the character of the rocks filling the interval, No. 6, was not ascertained.

The *St. Clair coal bed* was seen on Coal branch, Haines' Cabin branch and near the head of Sluss' branch, but no full exposure of the bed was found. It was opened at one time on the J. Bailey property near the head of Haines' Cabin branch, where it is said to have somewhat more than 4 feet of coal; but the opening is wholly filled up and only a few fragments of coal remain to show its place. Distinct blossoms were seen at many places near the divide, but none of them indicates a thickness of more than 18 inches. On the St. Clair property near Coal branch, the bed was fully exposed in an excavation for a spring-house and the thickness is said to be 2 feet. But only 19 inches were exposed at the time of examination.

The interval between the *St. Clair and Reed coal beds* is fairly well exposed on a stream leading from the St. Clair house to Coal branch, and contains little aside from sandstone, which varies from massive to more or less flaggy.

The *Reed coal bed* was found only on the waters of Sluss' branch and on the Tazewell and McDowell road. Its place is concealed at all other localities examined. The first exposure is on W. L. Reed's property on a fork of Sluss' branch, where 15 inches of coal are shown in the stream-bed, roofed by 10 inches of shale, underlying sandstone. The coal is prismatic in structure, rather soft, and contains a good deal of pyrites. An exposure on the same property, but on another fork of the stream, shows 2 feet 6 inches of coal, separated from the underlying sandstone by a few inches of clay. The blossom of the bed is shown on the Tazewell and McDowell road, which crosses it at barely a mile from the Nelson coal-pit.

No continuous exposure of the interval to the *Tabor coal bed* was found, but the whole of it was seen. It is occupied by sandstone almost unbroken by shale. The rock is comparatively fine-grained and shows no pebbles.

The *Tabor coal bed* was seen only on Sluss' branch, its horizon being concealed at all other localities examined. The exposures on Sluss' creek are imperfect, there being no opening in the bed. It was opened at one time on Mr. Tabor's property, but the opening has fallen in and only 1 foot of coal is shown. For 6 inches on top it is hard and bony, but below that, the coal as far as seen is good. The same bed is exposed on another fork of Sluss' branch, on W. L. Reed's property, where 3 feet of good coal were seen.

The *Coal Branch coal bed* is best shown on Coal branch at a few yards below the St. Clair crossing, but it is evidently the bed which was once opened on Elkanah Reed's property at the head of one fork of that branch; it was opened at one time in the bluff overlooking Laurel creek above Mr. Nelson's house, and its blossom is fairly shown in the Tazewell and McDowell road, at a little way from Laurel creek. Six feet of coal are exposed by a little run emptying into Coal branch near the St. Clair crossing, where 4 feet of shale separate the coal from the overlying sand-

stone. For 5 feet the coal is soft and clean, but below that is one foot of hard coal which seems to be quite bony. A blossom in the bank of the stream, and 15 feet above the water's edge, was stripped off and showed about 9 feet of coal, but the character and structure of the bed could not be ascertained. Samples for analysis were taken from the exposure in the run, an effort being made to obtain a section of the 5 feet there shown. As analyzed by Mr. A. S. McCreath, the coal has :

Water.....	1.225
Volatile combustible matter.....	21.435
Fixed carbon.....	74.603
Sulphur.....	0.435
Ash.....	2.302

It is a coking coal, altogether too soft for shipping. The coke should be of exceptional purity, but the amount of volatile matter is so small as to make the strength somewhat doubtful. No full exposure of this bed was seen on Laurel creek, but at the old opening near Nelson's, on that creek, the thickness is said to be about 6 feet. The bed is nearly 90 feet above Laurel creek at the mouth of Coal branch.

The interval between the *Coal branch* and *Nelson* coal beds is occupied by a more or less flaggy sandstone which forms bold cliffs along Laurel creek and Coal branch. It was not followed above the mouth of that branch. The upper bed rests almost directly on this sandstone and only a few feet of shale separate the cliff from the lower bed.

The *Nelson coal bed* is reached on the Tazewell and McDowell road as one approaches Laurel creek. There, at say one mile above the mouth of Laurel creek, Mr. Nelson has made an opening which has been pushed to about 25 feet. The working does not take in the whole bed, and the exposure at the mouth of the pit is such as to render measurement difficult. As nearly as could be made out, the structure of the bed is as follows :

1. <i>Coal</i>	5' 4''
2. <i>Bone</i>	0' 2''
3. <i>Coal</i>	0' 6''
4. <i>Bone</i>	0' 2''
5. <i>Coal</i>	2' 10''
6. <i>Clay</i>	0' 6''
7. <i>Coal</i>	1' 0''
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	10' 6''

Nos. 6 and 7 were not seen in detail, and the thicknesses are given according to Mr. Nelson's statement, these parts of the bed having been well exposed at an opening which he had abandoned.

The total thickness of the mined portion is about 7 feet, but there would be no difficulty in taking out fully 8 feet, as only a thin slab of coal need be left to strengthen the roof. Of the part above No. 6, the whole, excepting the two layers of bone, is good, the coal between these being nearly

equal to that of Nos. 1 and 5. The main body, No. 1, is brilliant, but shows many binders of mineral charcoal and an occasional pocket of the same material. No. 5 is not so brilliant as No. 1. The coal throughout the bed is prismatic and very soft, altogether too tender for chipping, but it cokes very readily. Samples from Nos. 1 and 5 were sent to Mr. A. S. McCreath for analysis. He reports the composition as follows :

Water	0.820
Volatile combustible matter	20.580
Fixed carbon	76.182
Sulphur	0.388
Ash	2.030

The only defect of the coal in No. 3, is that it contains some sulphur. This coal should yield a remarkably pure coke, though one not able to bear the burden of a high stack.

No other opening was seen along Laurel creek, but the bed can be followed without difficulty by means of the overlying sandstone down Laurel creek, and thence along Bluestone, but no estimate respecting it can be made from the imperfect exposures. An opening was worked at one time on Laurel creek above Nelson's, but it has been abandoned. There the total thickness is said to be about 11 feet. By means of the overlying sandstone, the bed was followed up the creek to the mouth of Coal branch, above which it soon goes under the stream, which in passing over it forms rapids, whereby the thickness is made to appear very great. The coal is shown for a short distance up Coal branch.

Only the blossom of *Coal bed*, No. 19, was seen. It has been ploughed up on Mr. Nelson's farm, and found to be 1 foot 6 inches thick. Its blossom is shown in a run entering at a little way above Nelson's house. It was not seen elsewhere. No. 21 is in the spring near the house, its only exposure as far as seen. No. 23 was not observed. It is said to be present in the bed of Laurel creek at about 300 yards below Nelson's house.

The dip is nearly 2 degrees at Nelson's pit, but soon becomes very gentle as one recedes from the influence of the Abb's Valley fault. Along Laurel creek the dip is insignificant.

On Simmons' creek, Mr. George Belcher has opened a coal bed at two places. The following measurement was made on his property :

1. St Clair coal bed	Blossom.
2. Sandstone	20'
3. Concealed	50'
4. Sandstone	35'
5. <i>Tabor coal bed</i>	4'

No. 1 is exposed imperfectly in the road near Mr. Belcher's house, but it has been ploughed up in an adjoining field, where its thickness is said to be somewhat more than 1 foot. The *Purdue coal bed* has been ploughed up near Mr. Belcher's barn, but its thickness was not ascertained. No ex-

posure occurs in the interval No. 3, in which the *Reed coal bed* belongs. At the upper opening in No. 5, the bed is now exposed to a thickness of 2 feet 6 inches, but it is said to be 3 feet 6 inches. The coal is harder than that of any bed fully seen on Laurel creek, but it is broken by many thin partings or binders, mostly of mineral charcoal. Sulphur is present in the top 10 inches, but below that the quantity is insignificant, and the coal is an excellent fuel. The bed is four feet thick at the other opening, and the bottom seems not to have been reached. A large bed, probably the *Nelson*, is said to be exposed at some distance further down the creek, but it was not examined.

A section was worked out hastily on Camp creek, beginning at the crest of Flat-top mountain. It is as follows :

1. Concealed	60'
2. Ferruginous sandstone	0' 10''
3. Concealed	37'
4. Yellow sandy shale	6'
5. <i>Coal bed</i>	Blossom.
6. Clay	1'
7. Yellow sandy shale	31'
8. <i>Purdue coal bed?</i>	1' 6''
9. Clay and variegated shale	15'
10. Sandstone	30'
11. Concealed	65'
12. <i>St. Clair coal bed</i> seen	1' 6''
13. Sandstone	90'
14. Shale with <i>Tabor coal bed</i>	1'
15. Sandstone or sandy shale	20'
16. Concealed, said to contain a <i>coal bed</i>	30'
17. Sandstone and some shale	40'
18. <i>Nelson coal bed</i> , seen	3'
19. Concealed	10'
20. Sandstone	25'
21. Shale and shaly sandstone	30'
22. Carbonaceous shale	0' 3''
23. Shale	16'
24. <i>Coal bed</i>	Blossom.
25. Imperfect exposure	55'
26. Sandstone	30'
27. Shales and sandstone, imperfectly exposed	100'
28. Sandstone	50'
29. Sandstones and shales	400'

Ending where the trail leading to Wolf creek crosses Camp creek, at a mile and a half above its mouth. This gives very nearly 600 feet of coal-bearing strata on Camp creek, the rocks below No. 26 being regarded as belonging to the Lower Carboniferous. No calculation for the dip was

made and a closer examination would doubtless lead to a moderate change in the thickness of several of the intervals.

The only coal beds which have been opened are Nos. 8, 12 and 18, but none of these was in shape for measurement at the time of examination. No. 12 is exposed in the bed of the run, and its thickness is said to be nearly 3 feet. The coal is clean, free from pyrites and slates, is soft and should yield a good coke. No. 18 was mined for local use at the junction of the forks of Camp creek. Its thickness is said to be 4 feet 2 inches. The coal is soft, clean and is admirably fitted for blacksmiths' use. No. 24 was once exposed near the creek at half a mile below Reed's mill. The thickness is said to be 3 feet.

The following section of the Lower Carboniferous rocks was obtained in passing from Little Bluestone to Mountain creek :

1. Conglomerate.....	20'
2. Imperfectly exposed.....	110'
3. Yellow shaly sandstone.....	45'
4. Concealed.....	25'
5. Gray to yellow shaly sandstone.....	80'
6. Imperfectly exposed.....	85'
7. Conglomerate.....	10'
8. Concealed.....	225'
9. Limestone.....	3'
10. Imperfectly exposed.....	370'
	973'

Exposures of dark red shales occur frequently in the intervals 2, 6 and 10, and No. 10 is made up almost wholly of such shales. This section brings one to the sandstone which forms the river bluffs in the vicinity of Hinton.

Notes on the Coal-field near Cañon City, Colorado. By John J. Stevenson, Prof. of Geology in the University of New York.

(Read before the American Philosophical Society, October 7, 1881.)

A small area of Laramie rocks lying along the easterly foot of the Greenhorn mountains has escaped erosion. Its shape is irregular and its breadth varies from two to five miles, being greatest at little more than midway north and south. The total area is not far from 70 square miles.

This little field, which has attained much economical importance, owing to the excellence of the coal from one of the beds, is deeply trenched by several streams which flow across it in cañons with walls from 200 to 500 feet high. The more important of these, beginning at the north, are Alkali gap, Chandler creek, Oak creek, Coal creek and Newland creek. Examinations more or less detailed were made in all except that of Newland creek.